A process for the HF-catalyzed alkylation of aromatic hydrocarbons is disclosed. A liquid-phase alkylation zone effluent stream comprising product alkylation aromatic hydrocarbon is passed into an intermediate point of a first fractionation column. A sidecut is removed from the first column at a higher intermediate point and passed into a sidecut stripping column. The bottoms stream of the sidecut stripping column contains the feed aromatic and about 4–10 mole percent paraffinic hydrocarbons and is recycled to the alkylation zone. The overhead vapor stream of the sidecut stripping column is passed into the first column to aid in fractionation.

8 Claims, 1 Drawing Figure
PROCESS FOR HF-CATALYZED ALKYLATION OF AROMATIC HYDROCARBONS

FIELD OF THE INVENTION

The invention relates to a hydrocarbon conversion process such as those often classified in Class 260. The invention more specifically relates to a process for the alkylation of aromatic carbon compounds by the introduction of an acyclic side chain using a catalyst comprising liquid-phase hydrogen fluoride. The invention is directly concerned with a process for the production of linear alkylbenzenes for use in detergent manufacture by the reaction of benzene with a C₆-C₂₀ monoolefin.

PRIOR ART

The alkylation of aromatic hydrocarbons using hydrogen fluoride as a catalyst is a well established art and is performed commercially on a large scale for the production of detergent grade alkylbenzenes. This process is commonly referred to as detergent alkylation. A representative example of the high state of the art is supplied by U.S. Pat. No. 3,950,448 (CL 260-671B). This reference describes the production of a soft detergent alkylate using a two reactor, two settling zone system similar in several respects to that preferred for use in the subject process. The reference also describes the regeneration of the HF used as catalyst and the purification of the products produced by the process.

U.S. Pat. No. 3,950,448 also describes one method for the fractionation of the hydrocarbon phase removed from the alkylation zone. U.S. Pat. No. 3,426,092 (CL 260-671) describes a highly similar but more commonly used fractionation method. In both of these references, the paraffins contained in the hydrocarbonaceous effluent of the alkylation zone are concentrated into an overhead stream which is substantially free of other types of hydrocarbons.

U.S. Pat. Nos. 3,275,702 (CL 260-671); 3,494,971 (CL 260-671); 3,501,543 (CL 260-674); 3,501,544 (CL 260-674); 3,830,865 (CL 260-671R) and 3,484,498 (CL 260-671) also describe the production of detergent alkylates.

The passage of the overhead vapor stream of the HF regeneration column and the overhead vapor stream of the HF stripping column into a common single overhead condenser is practiced commercially.

BRIEF SUMMARY OF THE INVENTION

The invention provides an improved process for the HF-catalyzed alkylation of aromatic hydrocarbons. Both the capital and utilities cost of the process are improved. One embodiment of the invention may be broadly characterized as a process for the alkylation of benzene which comprises the steps of admixing liquid-phase benzene, a C₆-C₂₀ aliphatic monoolefinic hydrocarbon and a normal paraffinic hydrocarbon having the same carbon number as the olefinic hydrocarbon with a first recycle hydrocarbon stream comprising benzene and dissolved HF and a second recycle hydrocarbon stream comprising benzene and the paraffinic hydrocarbon to thereby form an alkylation zone charge stream; contacting the alkylation zone charge stream with liquid-phase HF within an alkylation zone; withdrawing from the alkylation zone a liquid-phase HF stream and a liquid-phase hydrocarbon stream comprising benzene, the paraffinic hydrocarbon, an alkylaromatic hydrocarbon and dissolved HF; passing the liquid-phase hydrocarbon stream into a first fractionation column from which there is removed a first overhead vapor stream comprising HF and benzene and a first bottoms stream comprising the alkylaromatic hydrocarbon and the paraffinic hydrocarbons, with the liquid-phase hydrocarbon stream entering the first fractionation column at a first intermediate point; removing a sidestream liquid stream comprising the benzene and the normal paraffinic hydrocarbon from the first column at a higher second intermediate point, and passing the sidestream into a second fractionation column which produces a second overhead vapor stream comprising benzene and a second bottoms stream comprising benzene and containing about 4 mole percent paraffinic hydrocarbons; passing the second overhead vapor stream into the first column at a third intermediate point; admixing the second bottoms stream with feed benzene as the previously specified second recycle hydrocarbon stream; condensing the first overhead vapor stream to produce a hydrocarbon liquid phase, and admixing a stream of this hydrocarbon liquid phase with the feed benzene as the previously specified first recycle hydrocarbon stream; and recovering the product alkylaromatic hydrocarbon from the first bottoms stream.

It is believed that heretofore the overhead vapor stream of the second column, which is normally referred to as the benzene column, has not been passed into the first column. It is also believed that the second column has not been designed and operated to produce a benzene recycle stream which contains a significant amount of paraffinic hydrocarbons. Rather, it is believed that customary practice has been to produce a benzene recycle stream which is substantially free of these hydrocarbons. Furthermore it is believed that heretofore the bottoms stream of the HF stripping column was passed into a column which produced an aromatic hydrocarbon rich overhead stream rather than one rich in paraffinic hydrocarbons.

BRIEF DESCRIPTION OF DRAWING

The Drawing illustrates the preferred embodiment of the invention. For clarity and simplicity, various subsystems and apparatus normally required for the successful operation of the process have not been shown. These items include flow and pressure control valves, heat exchangers, pumps, level control and monitoring systems, etc., which may be of customary design. This representation of the preferred embodiment is not intended to preclude from the scope of the invention those other embodiments set out herein or which are the result of reasonable and normal modification of the inventive concept by those skilled in the art.

Referring now to the Drawing, a stream of liquid phase high purity benzene in line 1 is admixed with a stream comprising a mixture of olefins and paraffins in line 2. The resultant admixture is carried by line 3 to the point at which it is joined by a third liquid stream comprising benzene and paraffins carried by line 5. The material flowing through line 4 is then admixed with a fourth liquid phase stream in line 6 which comprises benzene and dissolved HF. The resultant feed stream is a liquid phase mixture of benzene, olefins and paraffins. It is passed into an alkylation zone 8 through line 7. Also passed into the alkylation zone is a stream of liquid-phase HF carried by line 20.

Two effluent streams are removed from the alkylation zone 8. These effluent streams are the result of the
DETAILED DESCRIPTION

One of the more important HF acid catalyzed alkyla-
tion reactions is the production of detergent grade al-
kylated aromatic hydrocarbons. This "detergent alkyl-
ate" is formed by the reaction of benzene with an ole-
finic hydrocarbon having from seven to twenty carbon
atoms per molecule. A better quality detergent precur-
 sor normally results from the use of olefinic hydrocar-
bons having from about ten to fifteen carbon atoms
per molecule.

The detergents produced from the resulting alkylated
aromatic hydrocarbons are classified either as "soft" if
they meet certain standards of biodegradability or as
"hard" if they are relatively nonbiodegradable. Soft
detergents are the result of using a long-chain monoole-
fin as the olefinic reactant. The preferred method of
producing these olefins is by the dehydrogenation of the
corresponding normal paraffins. The dehydrogena-
tion zone may be integrated with the detergent alkyla-
tion process as described in U.S. Pat. Nos. 3,413,373;
3,484,498 and 3,494,971. Hard detergents result from
the use of branched chain olefins such as propylene
tetramer produced in a catalytic condensation process.
The use of soft detergents is becoming more wide-
spread, and the subject invention will therefore be dis-
cussed primarily in terms of soft detergent production.

It is the objective of this invention to provide a pro-
cess for the HF-catalyzed production of alkylated aro-
matic hydrocarbons. It is a further objective to provide
an improved process for the production of linear alky-
benzenes suitable for use in the production of deter-
gents. It is a specific objective to reduce the capital
and utilities cost of an HF-catalyzed process for the pro-
duction of detergent alkylate.

The aromatic hydrocarbon which is alkylated in the
subject process is preferably benzene, but may be a
higher molecular weight aromatic hydrocarbon. The
feed aromatic hydrocarbon may therefore be toluene,
a xylene, ethylbenzene, phenol, naphthalene, etc. The
olefinic hydrocarbon which is consumed in the produc-
tion of detergent alkylate may have from about 6–20
carbon atoms per molecule. A better quality detergent
precursor normally results from the use of linear ole-
finic hydrocarbons having from 10–15 carbon atoms
per molecule. When these olefinic hydrocarbons are
produced in a dehydrogenation process which is integra-
ted with the alkylation process, it is common practice to
pass the unseparated paraffin/olefin mixture produced
as the effluent of dehydrogenation process into the
alkylation process as the olefin-containing feed stream.
This is basically because of the high cost of separating
olefins and paraffins of the same carbon number. The
olefin-containing feed stream charged to the alkylation
process may therefore contain from about 30 to about
70 mol% of paraffins having the same number of car-
bon atoms per molecule as the olefinic hydrocarbons.
These relatively non-reactive paraffins pass through the
alkylation process in the various hydrocarbon phase
streams and are eventually separated from the alkylate
by fractionation and then charged to the dehydrogena-
tion process.

As used herein, the term "alkylation zone" is in-
tended to indicate the process equipment in which the
aromatic hydrocarbon and the olefin are reacted and in
which subsequent contacting, treating and phase sepa-
ration steps are performed upstream of the passage of an
alkylate-containing hydrocarbon stream into a fraction-
ation zone. The preferred configuration of the alklyla-
tion zone comprises a first reaction zone, a first phase
separation zone, a second reaction (contacting) zone
and a second phase separation zone. Preferably, the
reactants and recycled HF are charged to the first
reaction zone and a single effluent stream comprising
the admixed HF and hydrocarbons is passed from the
first reaction zone to the first settling zone. A hydrocar-
bon phase which forms in the first settling zone is then
passed into the second reaction zone in admixture with
newly regenerated HF. The total effluent of the second
reaction zone is then passed into the second separation
zone. The hydrocarbon phase which forms in the sec-
ond separation zone is passed into the HF stripping
column. Other alklylation zone flow schemes and ar-
rangements may also be used in conjunction with the
inventive concept.

Chemical reactions which involve olefinic hydrocar-
bons and which are catalyzed by hydrogen fluoride
usually proceed at a very fast rate. To reduce the
amount of olefin polymerization and to promote the
production of a mono-alkylated aromatic product, the
reactants are normally subjected to vigorous mixing and
agitation at the point of initial contact of the olefinic
hydrocarbons and the liquid-phase hydrogen fluoride.

The desired result is a uniform dispersion and intimate
contacting of the hydrocarbon and hydrogen fluoride
phases and the avoidance of localized high temperatures
or localized high concentrations of either the olefinic
hydrocarbon or the hydrogen fluoride. The initial con-
tacting of the reactants and the catalyst has been done in
a number of different ways. For instance, the olefinic
hydrocarbons have been sprayed into a mixture of hy-
drogen fluoride and hydrocarbons through nozzles, and
mixtures of the reactants have been released into edu-
cators as high velocity streams which cause the eduction
4,134,734 describes a unitary reactor for the production of
detergent alkylate. U.S. Pat. No. 4,072,730 describes
a process for producing detergent alkylate in which a
centrifugal pump is utilized as the first reaction zone
due to the intense agitation which occurs within the
pump.

The reaction zone is maintained at alklylation-promot-
ing conditions. As used herein, the term "alklylation-
promoting conditions" is intended to include a pressure
sufficient to maintain the reactants and HF in a liquid
phase. A general range of operating pressures is from
about 2 to 41 atmospheres absolute. The temperature
range covered by this set of conditions is from about
-20°C to about 95°C, but the reaction is preferably
conducted at a temperature of from 15°C to 50°C. The
volumetric ratio of HF to the total amount of hydrocar-
bons entering the first reaction zone should be main-
tained within the broad range of from about 0.2:1.0 to
about 10:1. A preferred range for this ratio is from
1.0:1.0 to 2.5:1.0. To lessen the production of polyalkyl-
ated benzenes and to reduce the amount of olefin poly-
merization in the first reaction zone, the mole ratio
of benzene to the monoolefin at the point of initial ole-
fin-acid contact is maintained above 1.0:1.0, but prefer-
ably below 10.0:1.0. A range of typical commercial ratios
is from 3.0:1.0 to about 8.0:1.0.

The conditions maintained within the contacting
zone, which is referred to as the second reaction zone in
most prior art references, are similar to these alklylation-
promoting conditions, but some adjustment is required.
For instance, since essentially all of the olefin has been
consumed in the first reaction zone, the hydrocarbon
stream fed to the contacting zone is substantially free of
olefins. There is therefore no benzene to olefin ratio
to be specified. The same pressure range may be used in
the contacting zone as in the reaction zone, but a higher
temperature is preferred. This higher temperature
should be at least 6 to 10 Centigrade degrees above that
used in the reaction zone. All temperatures specified
herein are intended to refer to the average temperature
of the liquid stream entering the respective zone.

The acid-hydrocarbon ratio maintained in the con-
tacting zone will normally be slightly lower, and a typi-
cal ratio is about 1:1. The purity of acid used in the
contacting zone will, however, be higher. This is pre-
ferred because of the greater effectiveness of higher
purity acid for the treatment of the alkylate. This treat-
ment consists of the deaeration of the alkylate prod-
uct and the extraction of naphthenals and aromatics.
A higher acid purity is obtained by admixing the newly
regenerated acid into the alkylate-containing hydrocar-
bon stream entering the contacting zone. The recycle
acid used in the reaction zone is withdrawn from the
second settling zone and therefore contains a higher
concentration of high molecular weight hydrocarbon-
aceous impurities. The acid used in the reaction and
contacting zones may be from about 85-92 wt.% HF
and will typically be about 90 wt.% HF. The acid used
in the third reaction zone preferably contains more than
90 wt.% HF and is typically about 93-94 wt.% HF.

The effluent streams leaving the reaction zone and
the contacting zone will typically be an intimate admix-
ture of liquid phase hydrocarbons and liquid phase hy-
drogen fluoride. They may be in the form of a true
emulsion. A considerable residence time is normally
required to separate these two liquid phases, and the
effluent streams are therefore passed into settling zones.

The two settling zones will normally be maintained at
a temperature which is set by the entering HF-hydro-
carbon mixtures withdrawn from the respective up-
stream zones. They will therefore be at substantially
the same temperature as the immediately upstream reaction
or contacting zone. The same is also normally true for
the pressures used in the settling zones after adjustment
for any pressure change due to liquid flow and elevation
differences. The settling zones may however be down-
stream of control valves and therefore operated at a
somewhat reduced pressure. This reduced pressure,
however, must be superatmospheric and sufficient to
maintain liquid phase conditions. A residence time for
both the acid and hydrocarbon phases in the settling
zones should be in excess of 10 minutes but less than 30
minutes.

Those skilled in the art are familiar with the regenera-
tion of the HF acid catalysts. Information about the
apparatus and conditions utilized for this operation is
contained in the previously cited patents and also in
U.S. Pat. No. 3,721,720. The regeneration operation is
often accomplished by stripping the acid under condi-
tions sufficient to decompose alkylfluorides and to pro-
duce an overhead vapor stream containing HF and a
small amount of vapor phase hydrocarbons. If desired,
a stripping media comprising a relatively volatile hy-
drocarbon may be charged to the bottom of the HF
regeneration column. Benzene available within the pro-
cess is a suitable stripping media. Use of a stripping
media is optional and reduces the temperature required
at the bottom of the HF regeneration column. The HF
The liquid-phase hydrocarbon stream which contains the product alkylate and which is withdrawn from the alkylation zone is passed into a fractionation column referred to herein as the HF stripping column and as the HF stripper. This is in accordance with the customary nomenclature used in describing the various components of an HF-catalyzed alkylation process.

In the practice of the subject invention, the liquid-phase hydrocarbon stream withdrawn from the alkylation zone is passed into the HF stripping column at an intermediate point. As used herein, the term "intermediate point" and similar terms is intended to indicate a point in the fractionation column which is separated from each end of the column by at least three fractionation trays. It has been customary to feed this stream into the top of the HF stripping column. It also has been customary to pass the net bottoms stream of the HF stripping column into a second column referred to as the benzene column when benzene is consumed in the process. Substantially all the unreacted benzene was concentrated into the overhead stream of this column and then recycled to the alkylation zone.

In the subject process, the net bottoms stream of the HF stripping column is passed into the column which in the normal fractionation sequence is referred to as the paraffin column. This is possible because, unlike the prior art process flows, the bottoms stream of the HF stripping column is free of benzene or any other feed aromatic hydrocarbon. The total absence of benzene may not be possible. However, this stream should be substantially free of benzene, which is intended to indicate an aromatic hydrocarbon concentration of less than 0.5 mole %. Representative conditions for the operation of the HF stripping column include an overhead vapor temperature of about 250° F. at a pressure of approximately 36 psig. In the prior art processes, there is normally no external reflux to this column. However, in the subject process, reflux is supplied from the overhead receiver. The overhead vapor stream of the HF stripping column is normally condensed by cooling it to about 100° F. or less.

A sidestream is removed from the HF stripping column at an intermediate point above the feed point of the column. The number of trays separating the feed point and this upper second intermediate point should be sufficient to ensure that the liquid present at this point in the column has a very low concentration of the product alkylate. This sidestream is passed into the top of a sidestream stripper column which functions as the benzene column in the subject process. The overhead vapor stream of this column is passed into the HF stripping column at a third intermediate point which is above the feed point of the HF stripping column. Preferably, the third intermediate point is above the second intermediate point. The bottoms stream of the sidestream column will contain at least 4.0 mole percent paraffins. The paraffin concentration in this stream is preferably between 5 and 10 mole percent, but higher concentrations may be also maintained in this stream.

The net bottoms stream of the HF stripping column is passed into a fractionation zone in which the product alkylate is recovered. Preferably, this zone contains a third fractionation column which is referred to as the paraffin column. Non-reactive paraffins are removed from this column as an overhead liquid stream. The bottoms stream of the third fractionation column comprises the product alkylate and any higher molecular weight hydrocarbons formed by side reactions. This bottoms stream is passed into a fourth fractionation column which produces a high-purity net overhead stream containing the detergent alkylate which is removed as a product stream. A bottoms stream comprising polymerized olefins and polyalkylated benzene (heavy alkylate) is removed for disposal. The third and the fourth fractionation columns are normally operated at a subatmospheric pressure. An alternative method of performing this separation is disclosed in U.S. Pat. No. 3,950,448.

One embodiment of the invention may be characterized as a process for the alkylation of aromatic hydrocarbons which comprises the steps of forming an alkylation zone charge mixture by admixing a liquid-phase hydrocarbon feed stream comprising an aromatic hydrocarbon, an aliphatic monoolefinic hydrocarbon having from about 7 to 20 carbon atoms per molecule and a normal paraffinic hydrocarbon having the same number of carbon atoms per molecule as the monoolefinic hydrocarbon, a first recycle hydrocarbon stream comprising the aromatic hydrocarbon and dissolved HF, and a second recycle hydrocarbon stream comprising the aromatic hydrocarbon and the normal paraffinic hydrocarbon; contacting the alkylation zone charge stream with liquid-phase HF within an alkylation zone maintained at alkylation-promoting conditions; withdrawing from the alkylation zone a liquid-phase HF stream and a liquid-phase hydrocarbon stream comprising the aromatic hydrocarbon, the normal paraffinic hydrocarbon, an alkylation hydrocarbon and dissolved HF, passing the liquid-phase hydrocarbon stream into a first fractionation column from which there is removed a first overhead vapor stream comprising HF and the aromatic hydrocarbon and a first bottoms stream comprising the alkylation hydrocarbon and the normal paraffinic hydrocarbon, with the liquid-phase hydrocarbon stream entering the first fractionation column at a first intermediate point; removing a sidestream liquid stream comprising the aromatic hydrocarbon and the normal paraffinic hydrocarbon from the first fractionation column at a higher second intermediate point, and passing the sidestream liquid stream into a second fractionation column operated at conditions effective to produce a second overhead vapor stream which comprises the aromatic hydrocarbon and a second bottoms stream which comprises the aromatic hydrocarbon and which has a normal paraffinic hydrocarbon concentration above about 5 mole percent; passing the second overhead vapor stream into the first fractionation column at a third intermediate point which is above the second intermediate point; admixing the second bottoms stream with the liquid-phase hydrocarbon feed stream as the second recycle hydrocarbon stream; condensing the first overhead vapor stream to produce a hydrocarbon liquid phase, and admixing a stream of the hydrocarbon liquid phase with the liquid-phase hydrocarbon feed stream as the first recycle hydrocarbon stream; and passing the first bottoms stream into a fractionation zone in which the product alkylolefinic hydrocarbon is recovered.

The presence of paraffinic hydrocarbons in the bottoms stream of the sidestream stripper is both unique and beneficial. Since it is not attempted to totally reject these hydrocarbons from the top of the column, the separation is relatively easy and the alkylation conversion is relatively low. The sidestream stripper will therefore require fewer fractionation trays and will be less costly.
The paraffins in the bottoms stream pass through the alkylation substantially unaffected and may be considered as additional diluent. There is an improvement over prior art processes in that the latent heat content of the overhead vapor stream of the sidestream is utilized within the process. This heat and some sensible heat aids in the fractionation performed in the upper portion of the HF stripping column. It is therefore not immediately rejected as low level heat in the overhead condenser. This should reduce the utilities cost of operating the columns. In addition, the overhead condenser which receives the vapors of the prior art benzene column is no longer required. Only one overhead condenser is required for three columns. This lowers both the required equipment and the utilities cost of condensing the overhead vapors as compared to the prior art.

The capital cost and the operating cost of the alkylation process are therefore reduced.

I claim as my invention:

1. In a process for the production of linear alkylaromatic hydrocarbons which comprises the steps of:
   (a) contacting a liquid-phase hydrocarbon mixture comprising benzene, and aliphatic monoolefinic hydrocarbon having from about 7 to 20 carbon atoms per molecule and a normal paraffinic hydrocarbon having the same number of carbon atoms per molecule as the aliphatic monoolefinic hydrocarbon with liquid-phase HF within an alkylation zone maintained at alkylation-promoting conditions;
   (b) withdrawing from the alkylation zone a liquid-phase hydrocarbon stream comprising benzene, the normal paraffinic hydrocarbon, an alkylationaromatic hydrocarbon and dissolved HF;
   (c) passing the liquid-phase hydrocarbon stream into a first fractionation column from which there is removed a first overhead vapor stream comprising HF and benzene and a first bottoms stream comprising the aliphatic monoolefinic hydrocarbon and the normal paraffinic hydrocarbon; the improvement which comprises:
   (i) passing the liquid-phase hydrocarbon stream into the first fractionation column at a first intermediate point;
   (ii) removing a sidestream liquid comprising benzene, HF, and the normal paraffinic hydrocarbon from the first fractionation column at a higher second intermediate point and passing the sidestream liquid into a second fractionation column operated at conditions effective to produce a second overhead vapor stream which comprises benzene and HF and a second bottoms stream which comprises benzene and which has a normal paraffinic hydrocarbon concentration above 4.0 mole percent;
   (iii) passing the second overhead vapor stream into the first fractionation column at a third intermediate point;
   (iv) passing the second bottoms stream into the alkylation zone and;
   (v) passing the first bottoms stream into a fractionation zone in which the product alkylaromatic hydrocarbon is recovered.

2. The improvement of claim 1 further characterized in that the concentration of the normal paraffinic hydrocarbon in the second bottoms stream is between 5.0 and about 10.0 mole percent.

3. A process for the alkylation of aromatic hydrocarbons which comprises the steps of:
   (a) forming an alkylation zone charge liquid by admixing a liquid-phase hydrocarbon feed stream comprising an aromatic hydrocarbon, an aliphatic monoolefinic hydrocarbon having from about 7 to 20 carbon atoms per molecule and a normal paraffinic hydrocarbon having the same number of carbon atoms per molecule as the monoolefinic hydrocarbon, a first recycle hydrocarbon stream comprising the aromatic hydrocarbon and dissolved HF, and a second recycle hydrocarbon stream comprising the aromatic hydrocarbon and the normal paraffinic hydrocarbon;
   (b) contacting the alkylation zone charge liquid with liquid-phase HF within an alkylation zone maintained at alkylation-promoting conditions;
   (c) withdrawing from the alkylation zone a liquid-phase HF stream and a liquid-phase hydrocarbon stream comprising the aromatic hydrocarbon, the normal paraffinic hydrocarbon, an alkylationaromatic hydrocarbon and dissolved HF;
   (d) passing the liquid-phase hydrocarbon stream into a first fractionation column from which there is removed a first overhead vapor stream comprising HF and the aromatic hydrocarbon and a first bottoms stream comprising the aliphatic monoolefinic hydrocarbon and the normal paraffinic hydrocarbon, with the liquid-phase hydrocarbon stream entering the first fractionation column at a first intermediate point;
   (e) removing a sidestream liquid stream comprising the aromatic hydrocarbon and the normal paraffinic hydrocarbon from the first fractionation column at a higher second intermediate point, and passing the sidestream liquid into a second fractionation column operated at conditions effective to produce a second overhead vapor stream which comprises the aromatic hydrocarbon and a second bottoms stream which comprises the aromatic hydrocarbon and which has a normal paraffinic hydrocarbon concentration above about 4 mole percent;
   (f) passing the second overhead vapor stream into the first fractionation column at a third intermediate point;
   (g) admixing the second bottoms stream with the liquid-phase hydrocarbon feed stream as the second recycle hydrocarbon stream of step (a);
   (h) condensing the first overhead vapor stream to produce a hydrocarbon liquid phase, and admixing a stream of the hydrocarbon liquid phase with the liquid-phase hydrocarbon feed stream as the first recycle hydrocarbon stream of step (a); and,
   (i) passing the first bottoms stream into a fractionation zone in which the product alkylaromatic hydrocarbon is recovered.

4. The process of claim 3 further characterized in that the concentration of the normal paraffinic hydrocarbon in the second bottoms stream is between 5.0 and about 10.0 mole percent.

5. The process of claim 4 further characterized in that the first bottoms stream is substantially free of the aromatic hydrocarbon.

6. The process of claim 5 further characterized in that the third intermediate point is above the second intermediate point.

7. The process of claim 6 further characterized in that the aromatic hydrocarbon is benzene.

8. The process of claim 7 further characterized in that the aliphatic monoolefinic hydrocarbon has from 10 to 15 carbon atoms per molecule.

* * * * *